

AMENDMENTS TO THE SPECIFICATION:

Page 1, please add the following new paragraphs before paragraph [0001]:

[0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.4] This application is a 35 USC 371 application of PCT/DE 03/00883
filed on March 18, 2003.

[0000.6] BACKGROUND OF THE INVENTION

Please replace paragraph [0001] with the following amended paragraph:

[0001] ~~Prior Art~~ Field of the Invention

Please replace paragraph [0002] with the following amended paragraph:

[0002] The invention is directed to an improved ~~based on a~~ fuel injection apparatus for an internal combustion engine of the type including a fuel supply pump that delivers fuel to at least one high pressure pump which in turn delivers high pressure fuel to a reservoir as generically defined by the preamble to claim 1.

Please add the following new paragraph after paragraph [0002]:

[0002.2] Description of the Prior Art

Please replace paragraph [0003] with the following amended paragraph:

[0003] A fuel injection apparatus ~~of this kind is~~ known from DE 198 53 103 A1: ~~This fuel injection apparatus~~ has a fuel supply pump that delivers fuel to at least one high-pressure pump, which in turn delivers highly pressurized fuel to a reservoir. In addition, a fuel metering device is provided between the fuel supply pump and the high-pressure pump. The fuel metering device serves to control the quantity of fuel that the high-pressure pump delivers into the reservoir in accordance with operating parameters of the internal combustion engine. The fuel metering device includes an actuator in the form of an electromagnet and a check valve that is actuated by it, which has a slider-shaped valve element that is guided in a

cylindrical bore of a valve housing and can be slid by an armature of the electromagnet in opposition to a return spring. The outer circumferential **circumference** surface of the valve element, in cooperation with an outlet opening in the valve housing, controls a flow cross section from the fuel supply pump to the high-pressure pump in a stroke-dependent manner. When the valve element is in a closed position, its outer circumferential **circumference** surface overlaps the outlet opening so that the flow cross section is completely closed. But since the valve element must be able to slide in the cylindrical bore of the valve housing, there must be a slight amount of play between its outer circumference and the cylindrical bore, through which a leakage quantity of fuel can flow and travel via the outlet opening to the high-pressure pump, even when, due to the operating parameter of the engine, for example when overrunning, the high-pressure pump is not supposed to deliver any fuel, during a so-called zero delivery. It is therefore necessary for steps to be taken in order to drain away this leakage quantity of fuel so that it cannot travel to the high-pressure pump and so that the zero delivery is achieved. To this end, a throttled connection to a discharge region can be provided; but in this case, fuel downstream of the fuel metering device constantly drains into the discharge region and in addition, there is an increased pressure level between the fuel metering device and the high-pressure pump. In order to prevent the high-pressure pump from taking in fuel, the opening pressure of at least one intake valve of the high-pressure pump must be set to a correspondingly high level; this, however, has a negative impact on the volumetric efficiency of the high-pressure pump. On the whole, this consequently requires a more complex design and more expensive manufacture of the fuel injection apparatus.

Page 2, please replace paragraph [0004] with the following amended paragraph:

[0004] SUMMARY AND ADVANTAGES OF THE INVENTION

~~Advantages of the Invention~~

Please replace paragraph [0005] with the following amended paragraph:

[0005] The fuel injection apparatus according to the invention, ~~with the characterizing features of claim 1,~~ has the advantage over the prior art that when the valve element closes the flow cross section between the fuel supply pump and the high-pressure pump in order to achieve zero delivery, it opens a connection to a discharge region, which permits drainage of the fuel delivered by the fuel supply pump or of other fuel traveling into the high-pressure pump due to a leakage in the fuel metering device. Fuel is therefore drained into the discharge region only during zero delivery, during which the high-pressure pump is not supposed to deliver any fuel. This prevents a drop in fuel quantity particularly when starting the engine, when it is necessary for the high-pressure pump to deliver a large quantity of fuel. Only a low pressure is produced between the fuel metering device and the high-pressure pump since the valve element closes the flow cross section and opens the connection to the discharge region, through which the fuel delivered by the fuel supply pump or fuel traveling to the high-pressure pump due to leakage is drained away, thus making it possible to set the opening pressure of at least one intake valve of the high-pressure pump to a low level and nevertheless assure zero delivery. This permits a favorable filling and good volumetric efficiency of the high-pressure pump. The advantage of the outlet from the fuel metering device toward the high-pressure pump being connected to the discharge region is that the delivery pressure of the fuel supply pump is maintained between the fuel supply pump and the fuel metering device, which prevents irregularities in the march of pressure upstream of the fuel metering device and thus permits an improved adjustment of the pressure in the

reservoir by means of the fuel metering device. In addition, the design ~~features of claim 1~~ correspondingly simplifies ~~simplify~~ the design and manufacture of the fuel injection apparatus since no additional steps are required for the zero delivery.

Page 3, please delete paragraph [0006].

Please replace paragraph [0007] with the following amended paragraph:

[0007] ~~Drawings~~ BRIEF DESCRIPTION OF THE DRAWINGS

Please replace paragraph [0008] with the following amended paragraph:

[0008] Other features and advantages of the invention will become apparent from the description contained below, taken in conjunction with the drawings, in which: ~~A number of exemplary embodiments of the invention are shown in the drawings and will be explained in detail in the subsequent description.~~

Page 4, please replace paragraph [0014] with the following amended paragraph:

[0014] ~~Description of the Exemplary Embodiments~~

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Page 5, please replace paragraph [0017] with the following amended paragraph:

[0017] The high-pressure pump 14 can be embodied as a radial piston pump and has at least one, preferably several, pump elements 30, disposed at uniform angular distances from one another, which are each set into a stroke motion by means of a cam ~~polygon~~ 32 in connection with a camshaft and each have a pump piston 34, which is guided in a cylinder bore 33 and delimits a pump working chamber 36. The connection leading from the pump working chamber 36 to the reservoir 16 contains a check valve 38 that opens toward the reservoir 16,

serves as an outlet valve, and disconnects the pump working chamber 36 from the reservoir 16 during the intake stroke of the pump piston 34. The connection from the pump working chamber 36 to the fuel supply pump 12 contains a check valve 39 that opens toward the pump working chamber 36, serves as an intake valve, and disconnects the pump working chamber 36 from the fuel supply pump 12 during the delivery stroke of the pump piston 34. During an intake stroke of the pump piston 34, in which it moves radially inward, the opening intake valve 39 connects the pump working chamber 36 to the outlet of the fuel supply pump 12 so that the pump working chamber 36 is filled with fuel; the closed outlet valve 38 disconnects the pump working chamber 36 from the reservoir 16. During a delivery stroke of the pump piston 34, in which it moves radially outward, the pump working chamber 36 is connected to the reservoir 16 by the open outlet valve 38 and is disconnected from the outlet of the fuel supply pump 12 by the closed intake valve 39.

Page 7, please replace paragraph [0020] with the following amended paragraph:

[0020] Figs. 2 and 3 show enlargements of the fuel metering device 44 according to a first exemplary embodiment. As part of the control valve 46, the fuel metering device 44 has a valve housing 50 in which a valve element 54 embodied in the form of a hollow piston is guided so that it can slide in a cylinder bore 52. The valve element 54 is cup-shaped; its bottom 55 and its circumferential ~~circumference~~ surface can also be separate components that are connected to each other. The bottom 55 of the valve element 54 can also constitute a magnet armature of the actuator 45. The bottom 55 of the valve element 54 has at least one opening 57. The cylinder bore 52 in the valve housing 50 has an outlet 56 leading from it in an at least approximately axial direction, which leads to the high-pressure pump 14. The open end of the valve element 54 is oriented toward the opening 56. The valve element 54 is

at least approximately pressure-balanced by means of the at least one opening 57 in the bottom 55. The actuator 45 engages the valve element 54 at its end oriented away from the opening 56. A support ring 58 is inserted into the cylinder bore 52, for example is press-fitted into it, and a spring 60 that extends into the valve element 54 is clamped between this support ring 58 and the bottom of the valve element 54. The position of the support ring 58 can be adjusted in the direction of the longitudinal axis 53 of the cylinder bore 52 to thus permit the setting of the initial stress of the spring 60. The support ring 58 has an opening that allows the fuel emerging from the opening 56 to pass through.

Page 8, please replace paragraph [0021] with the following amended paragraph:

[0021] An inlet from the pressure side of the fuel supply pump 12 feeds into the circumference of the cylinder bore 52 through at least one opening 62. It is also possible for a number of openings 62 to be provided that are distributed over the circumference of the cylinder bore 52. The opening 62 can be embodied in the form of a slot that extends around part of the circumference of the cylinder bore 52. Depending on the placement and number of openings 62 in the cylinder bore 52, the circumference of the valve element 54 has at least one opening 64 that can also be embodied in the form of a slot extending around part of the circumference of the valve element 54. The valve element 54, by means of its at least one opening 64 cooperating with the at least one opening 62 in the cylinder bore 52, controls the size of a flow cross section in the connection between the fuel supply pump 12 and the high-pressure pump 14. A different size of flow cross section is opened depending on how much the opening 64 of the valve element coincides with the opening 62 of the cylinder bore 52. The valve element 54 changes the size of the flow cross section depending on its position in the direction of the longitudinal axis 53 of the cylinder bore 52. Fig. 2 shows the valve

element 54 in an axial position in which its opening 64 completely coincides with the opening 62 of the cylinder bore 52, thus opening the maximum flow cross section. Fig. 3 shows the valve element 54 in an axial position in which the actuator 45 has slid it to the left ~~60~~ in opposition to the spring 60 and its opening 64 no longer coincides with the opening 62 of the cylinder bore 52 so that the flow cross section is closed.

Page 10, please replace paragraph [0024] with the following amended paragraph:

[0024] Fig. 4 shows the fuel metering device according to a second exemplary embodiment in which the design is largely the same as in the first exemplary embodiment. By contrast with the first exemplary embodiment, the valve element 54 in the second exemplary embodiment has only the at least one opening 64 that controls the size of the flow cross section between the fuel supply pump 12 and the high-pressure pump 14. The circumference of the cylinder bore 52 has the at least one opening 62, with the at least one additional opening 66 disposed offset from it at a relatively large axial distance, which additional opening produces the connection to the discharge region. By means of its circumferential ~~circumference~~ surface, the valve element 54 controls the opening process of the opening 66 and therefore the connection to the discharge region in such a way that the opening 66 is closed when the valve element 54 completely overlaps the opening 66 and the opening 66 is opened when the valve element 54 does not overlap or only partially overlaps the opening 66. As in the first exemplary embodiment, the valve element 54 closes the opening 66 and therefore the connection to the discharge region as long as the valve element 54 opens a flow cross section via the openings 62, 64. Only when the valve element 54 has at least almost entirely closed the flow cross section via the openings 62, 64 does it open the opening 66 and therefore the connection to the discharge region.

Page 14, please add the following new paragraph after paragraph [0030]:

[0031] The foregoing relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.